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February 25, 1994

Mr. William F. Caton
Secretary
Federal Communications Commission
Room 222
1919 M Street NW
Washington, D.C. 20554

Re: PP Docket No. 93-253

Dear Mr. Caton:

On February 24, Dr. Peter Cramton of the University of Maryland, Larry Blosser and Rick Calder of MCI, and I met with David Reed, Gary Rosston, Jonathan Cohen, Don Gips, Kent Nakamura and Evan Kwerel of the Office of Plans and Policy. The purpose of the meeting was to review MCI's plans for wireless services, Dr. Cramton's recommendations on the design of the PCS spectrum auction and a letter sent from MCI to Chairman Hundt. The attached paper was distributed at the meeting.

Because the meeting was held late in the day, this note is being filed the next business day.

Sincerely,

Leonard S. Sawicki

Leonard S. Sawicki

Attachment

cc: Mr. Cohen
Mr. Gips
Mr. Kwerel
Mr. Nakamura
Mr. Reed
Mr. Rosston

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Further Comments on the Design of the PCS Spectrum Auction

Professor Peter Cramton
University of Maryland
23 February 1994

Table of Contents

Summary

To maximize social welfare, the FCC should adopt an auction design that assures rapid allocation of the PCS spectrum. Delay in licensing benefits cellular incumbents at the expense of consumers, new entrants, and the government. Each month of delay postpones and weakens competition as cellular incumbents and Pioneer Preference winners lock in customers. Auction revenues are reduced as delay erodes the value of PCS licenses to new entrants.

Costly delay can be avoided by simplifying the auction process. Specifically, the FCC should separate the MTA auction (blocks A and B) from the BTA auction (blocks C to G) and conduct the MTA auction before the BTA auction. Separating the MTA and BTA auction (1) prevents the MTA auction from getting bogged down in the complexities associated with the large number of licenses and bidders at the BTA level, (2) prevents the MTA auction from getting snarled in legal challenges over the set-aside of the C and D blocks, (3) allows greater flexibility in the design of the BTA auction, and (4) is consistent with likely bidding strategies. Conducting the MTA auction before the BTA auction allocates the most valuable part of the spectrum quickly. In addition, the MTA auction reveals important valuation information to smaller BTA bidders, improving the efficiency of the BTA auction.

To further simplify the MTA auction, combination bids, including a national bid, should not be allowed. Combination bids greatly complicate the auction. The value they add does not justify the additional complexity. Even national bidding, which offers significant advantages in promoting an efficient national aggregation, adds complexity and introduces design problems. For example, it is difficult for the FCC to implement national bidding in a way that favors neither national nor regional bidders. Moreover, national bidding may not be viable in the proposals under consideration. To limit risk, national bidders are likely to bid in partnerships. Partnerships work well if a block of spectrum is reserved for national bidding. However, without this restriction, forming a nationwide partnership before the auction is nearly impossible. The uncertainties associated with a national bid are simply too great. Because of these difficulties, national bidding should be dropped in favor of a simpler auction design.

The FCC should adopt an auction design with the following features:

- *Combine the bidding for the A and B blocks in each MTA.* This reduces the number of MTA auctions from 99 to 51. Consolidating A and B makes sense, since the two blocks are close substitutes.
- *Auction the MTA licenses in sequence, not simultaneously.* A sequential auction reduces aggregation risk, collusion, and complexity relative to a simultaneous auction. Moreover,

a sequential auction is conducted on a specific schedule. This facilitates planning and guarantees a timely allocation of the spectrum.

- *Use a sequential English auction format.* The use of a familiar and proven auction format makes implementation easy, reduces the risk of breakdown, and simplifies bidding strategies.
- *Begin with the Pioneer Preference markets and then proceed from largest MTA to smallest.* Large MTAs represent key hubs in regional aggregations. Hence, this ordering improves efficiency and reduces aggregation risk.
- *Open and close the bidding on a license within a single session.* Conducting the auction of a particular license over multiple sessions greatly increases opportunities for collusion, as the identities of the high bidders become known. MTA bidders are sophisticated and well prepared. They can react to new information without lengthy breaks in the bidding.
- *Reveal bidder identities.* The bidders can then condition their bids on more information, reducing the winner's curse and increasing auction revenues. Since bidding on a license concludes without interruption, the collusion possibilities introduced by revealing identities are minimized.
- *Conclude the MTA auction within two weeks.* This pace gives the bidders time to incorporate new information, yet minimizes the opportunities for collusion.

By emphasizing simplicity, the FCC avoids the risks inherent in more complex proposals. The above design assures that the majority of the spectrum will be allocated without substantial delay. Moreover, the design is consistent with the goals of efficiency and revenue maximization.

I have been asked by MCI Telecommunications Corporation (MCI) to provide further comments on the design of the PCS Spectrum Auction. My comments are based on a reconsideration of the many issues of auction design. I believe a number of important points about auction implementation have been largely absent from the public record. It is these points I wish to emphasize.

My underlying assumption is that the FCC's goal in selecting an auction process is to maximize social welfare. This is best accomplished by designing the auction to maximize post-auction competition in telecommunication markets. My main argument is that social welfare will be enhanced by a simple auction of the MTA blocks that avoids delay and minimizes the opportunities for collusion.

Further consideration of some of the practical difficulties of the spectrum auction has caused me to modify two of my earlier recommendations. First, although I still believe that encouraging nationwide strategies by new entrants promotes the interests of social welfare, the current proposals for national bidding do not add sufficient value to justify their added complexity. Therefore, national bidding should be dropped in favor of a simple sequential English auction for the MTA licenses. Second, in my prior comments I argued that the bidders' identities should be hidden so as to reduce the possibility of collusion. I now believe that the gain from revealing identities (better bidder information) exceeds the cost (greater risk of collusion) provided other steps are taken to reduce collusion opportunities. In particular, I recommend that bidder identities be revealed so long as the bidding on a license begins and ends within the same session.

1 Conduct the auction as soon as possible.

Delaying the PCS auction benefits cellular incumbents and LECs at the expense of consumers, the government, and new entrants into wireless communications. Every month of delay is a month with little competition in the cellular and local exchange markets. Naturally, incumbents benefit from this lack of competition. Consumers are the most obvious losers, forced to pay higher prices for inferior service.

Delay also is costly to new entrants into wireless communications. With each month of delay, cellular incumbents become more entrenched, locking in customers as a result of significant switching costs. Cellular firms are now introducing digital networks in anticipation of PCS competition. For example, in the Washington area, both Bell Atlantic and Southwestern Bell will have digital networks by the end of March. (*Washington Post*, 23 February 1994, p. F1.) Customers will have to spend about $550 to $750 for digital phones that are incompatible with PCS. Because of this consumer lock-in, delay in licensing erodes

the value of PCS licenses to new entrants. Hence, the FCC can expect that delay not only will postpone auction revenues, but will reduce revenues.

Finally, delay unfairly benefits the Pioneer Preference winners by giving them a head start in the provision of PCS at the MTA level. A timely allocation of the remaining MTA licenses is needed to let PCS providers compete on an equal basis. Equal competition will both benefit consumers and increase government revenues from the auction.

The timing of the auction is one issue where there is no conflict between the goals of revenue maximization and efficiency. Both goals are best served if the auction is conducted as soon as possible. Certainly, Congress had this in mind when it set a specific and rapid timetable for awarding licenses.

2 Simplify the auction as much as possible.

There is enormous value in a simple auction design. Simplicity reduces the opportunities for strategic manipulation, reduces bidder confusion, and reduces the chance of a catastrophic breakdown in the auction process. The auction can be simplified by separating the MTA auction from the BTA auction, by auctioning the MTA licenses first, and by not allowing any combination bids, including a national bid.

2.1 Separate the MTA auction (A-B blocks) from the BTA auction (C-G blocks).

The primary source of complexity in the PCS auction comes from the large number of licenses and potential bidders at the BTA level. There are 2,460 BTA licenses and the bidders may number in the thousands. This large number problem introduces a significant risk that the BTA auction, despite the best planning, will involve substantial delays from unforeseen breakdowns. To avoid having the MTA auction marred by a BTA failure, the MTA auction should be separated from the BTA auction.

An additional advantage of separating the MTA and BTA auctions is that the MTA auction could begin more quickly. The FCC could decide on MTA auction rules in the beginning of March and, if necessary, postpone the BTA rules until the more complex BTA planning is finished. (I briefly discuss the BTA auction in the Appendix.) Since implementing the MTA auction is much easier, both finding a suitable auctioneer and allowing time for the auctioneer and bidders to prepare for the auction should not involve long delays.

By separating the MTA and BTA auctions, both auction designs can be tailored to their particular environments. The large differences in the scale of licenses, the size of the bidders, and the number of bidders and licenses suggests that the two auctions should reflect these differences. In addition, the separation will mean that novel auction designs can be considered for BTA licenses without fear of delaying deployment of the majority of the PCS spectrum.

Separating the two auctions is also prudent in light of legal challenges over the set-aside of the C and D blocks for designated entities. If the two auctions are linked, there is a significant risk that the entire allocation will be derailed by legal delays. A clean separation of the MTA and BTA auctions is needed to assure that this will not happen.

Separating the MTA and BTA auctions has few disadvantages. Although it eliminates some backup strategies, the strategies eliminated are unlikely. For example, the strategy of bidding on a set of BTAs and then switching to an MTA if the BTAs prove to be too expensive is eliminated. However, this type of strategy is implausible. For the most part, the BTA bidders will be distinct from the MTA bidders. To the extent that there is substitution, it is likely to go the other way. Failed MTA bidders might try to fill some holes with BTA licenses. This sort of substitution can still occur if the BTA auction follows the MTA auction. Even this substitution of BTAs for MTAs is of limited value for three reasons: (1) there are technical difficulties in building PCS equipment that operates in both the frequency range of the A-C blocks and the D-G blocks; (2) only designated entities (small, woman and minority owned businesses and small telephone companies) can bid on C and D; and (3) there are aggregation difficulties in forming an MTA block from BTA pieces.

2.2 Auction the MTA licenses first, then the BTA licenses.

Among those proposing sequential auctions, there is unanimous agreement that the MTAs should be auctioned first. There are several reasons for this conclusion. Auctioning the MTA licenses first allocates the most valuable part of the spectrum more quickly. It reveals information about values to the BTA bidders. This is especially important, since the BTA bidders are likely to be smaller and less able to invest in information. Allowing the BTA bidders to learn from the MTA bidding experience offsets any informational advantage large bidders may have. The FCC also can benefit from the MTA experience in implementing the BTA auction. Finally, conducting the MTA auction first assures that the MTA auction will not get mired in delays caused by the complexity of the BTA auction.

The substitution of BTAs for MTAs, although limited, is enhanced by conducting the MTA auction **before** the BTA auction. For example, suppose a bidder with a nationwide strategy is unable to acquire some key MTAs. A potential solution is to fill the holes with C block licenses, which are the most compatible with the A-B MTA blocks. The difficulty is that only designated entities can bid on the C block. Hence, the MTA bidder needs to form a partnership with designated parties. Knowing the allocation of the MTA licenses is essential to forming these partnerships, which in turn is essential to determining bidding strategies for the C block. In contrast, if the MTA and BTA auctions are simultaneous, partnerships would have to be formed before the MTA allocations are known. Moreover, BTA partners would be forced to bid on C blocks, because of activity rules, before the value of the C blocks to the

MTA partners is known. The value of the BTA blocks, therefore, is enhanced if BTA bidding follows the MTA auction.

2.3 To keep the auction simple, do not allow combination bids.

Combination bidding greatly increases the complexity of the MTA auction. In an effort to make the MTA auction as simple as possible, the FCC should not allow combination bids. Combination bidding raises a host of implementation problems: What combinations will be allowed? How is the winner determined? How is the free-rider problem avoided? More importantly, it makes the auction much more complex for the bidders. New possibilities for gaming are introduced, increasing the risk that the outcome will be distorted by unanticipated strategic manipulation.

Although combination bids may encourage efficient aggregations, they may go too far, leading to inefficient aggregations. Given the highly uncertain benefits of combination bidding, the FCC should err on the side of simplicity and not permit them.

2.4 To keep the auction simple, do not allow national bidding.

Even allowing just a single combination bid — a national bid — adds complexity that may not be worth the trouble. The advantage of national bidding is that it may permit the formation of an efficient nationwide aggregation. Such an aggregation may not form without national bidding because of aggregation risk and strategic hold out. However, there are practical problems in successfully implementing national bidding. The difficulty lies in coming up with a balanced auction design that offsets the disadvantages faced by national bidders (aggregation risk and strategic hold out). Unfortunately, none of the proposals considered to date accomplishes this balance.

The timing of national bidding illustrates the difficulty in settling on a balanced design. National bidding must occur either before, after, or simultaneously with regional bidding. If national bidding comes before regional bidding, then the national bidders face an insurmountable informational disadvantage relative to regional bidders. Hence, national bidding before regional bidding is essentially useless. National bidders, exposed to so much winner's curse, would be unable to compete with better informed regional bidders. If national bidding is held after regional bidding, then the regional bidders are disadvantaged because they are not given the opportunity to top a winning national bid. The rules could be adjusted to require that national bids must beat regional bids by a specified bid premium, but determining an appropriate bid premium is a difficult task. Finally, if national bidding is simultaneous with regional bidding, a simultaneous auction design must be adopted, which introduces problems of complexity and collusion discussed later.

An additional difficulty with national bidding stems from the enormous capital resources needed to submit a winning national bid. Few firms are willing or able to commit billions of dollars to acquiring a national license, even if they are pursuing a national strategy. PCS revenues are highly uncertain at this point in time. Firms will limit their exposure to this uncertainty. Hence, the most prudent means of forming a national bid is through a partnership of firms, each bringing a share of the required capital. The partnership approach works well if a block of spectrum is restricted to national bidding. However, without this restriction, forming a nationwide partnership before the auction is nearly impossible. Firms are rightly skeptical about entering a partnership when the chances of winning a national license appear small. It is one thing to commit to a partnership when it is known that a national license will be awarded; it is quite another when the prospects of a national license are so uncertain. Potential partners are more inclined to take their chances in the regional auctions and then form partnerships once the winners are announced. Risk averse firms will choose to bid at the MTA level, where they have a good chance of winning some licenses, rather than at the national level, where they have a small chance of a share in a national license.

On balance, the benefits of national bidding are outweighed by the costs from greater complexity. If national bidding were eliminated, the FCC could move forward with a simple design for the MTA auction, such as the one sketched in the next section.

3 A simple auction design for the MTA licenses

I propose an auction design with the following features: (1) combine the bidding for the A and B blocks in each MTA, (2) auction the MTA licenses in sequence, not simultaneously, (3) use a sequential English auction format, (4) begin with the B blocks in the Pioneer Preference markets (New York, Los Angeles, and Washington) and then continue from largest MTA to smallest, (5) open and close the bidding on a license within a single session, (6) reveal bidder identities, and (7) conclude the auction within two weeks. The rationale for each of these features follows.

3.1 Combine the bidding for the A and B blocks.

Combining the bidding for the A and B blocks in each MTA has three main advantages. First, it cuts in half the number of auctions from 99 to 51. Second, it removes an element of strategic risk that arises if the A and B blocks are offered in sequence. If the A block is auctioned first, bidders have to guess the likely price of the B block in deciding to raise a bid on the A block. This additional strategic risk, may discourage bidder participation and hence reduce revenues. Third, auctioning A and B together quickly resolves aggregation uncertainty

by determining the allocation of both MTA blocks. This reduction of uncertainty promotes efficient aggregations.

Auctioning the A and B blocks within an MTA simultaneously makes sense because they are close substitutes. Seamless roaming across A and B blocks is possible with existing PCS technologies and little additional cost. Hence, it is unlikely that a bidder's values for A and B differ by much. Valuation differences come mainly from the existence of interfering microwave operators on one block. Moving these operators involves both expense and delay, making the microwave encumbered block less valuable. However, because this valuation difference is common across bidders, combining A and B in a single auction is still efficient. Under the proposed design, bidders are able to compete for the better block by raising their bids. (The outcome could be inefficient if the bidders had idiosyncratic differences in the values for A and B. A bidder with a strong interest in A may stop bidding, incorrectly thinking that the other high bidder prefers B. This outcome, however, is unlikely.)

There is strong support in the auction docket for combining the A and B blocks. A minor disagreement concerns whether A and B for a particular MTA should be auctioned in two simultaneous ascending bid auctions (as recommended by TDS's expert Weber) or a single ascending bid auction with A and B going to the two highest bidders (as recommended by Bell Atlantic's experts Nalebuff and Bulow). I recommend the single ascending bid auction because of its simplicity. Since it is unlikely that bidders will have different preference orderings for A and B, there is little chance that combining the A and B blocks into a single auction will introduce inefficiencies.

3.2 The MTA licenses should be auctioned in sequence, not simultaneously.

There are serious practical difficulties with the simultaneous auction designs that have been proposed. These difficulties stem from increased aggregation risk, more opportunities for collusion, and greater complexity.

Although both sequential and simultaneous auctions expose the bidders to aggregation risk, this risk is less with a properly designed sequential auction. The difficulty with simultaneous auctions is that firms never know what they have until the auction is over. If a firm attempts to form a large aggregation based on current prices, it may find that key pieces of the aggregation later become too expensive. The firm is left inefficiently holding a number of licenses that only made sense if the key properties were acquired. The firm has paid for aggregation gains, but has failed to achieve the aggregation. Recognizing this possibility, the firm may choose not to bid on efficient aggregations. In contrast with a sequential auction, aggregation risk can be reduced by establishing ownership of key properties first.

Simultaneous auctions reveal a great deal of preliminary price and ownership information as the auction proceeds. Sequential auctions reveal information on fewer licenses, but the price and ownership information that is revealed is final. It is not at all clear that a lot of tentative information is necessarily better than a smaller quantity of final information about prices and ownership. Indeed, I suspect that actual sales information will prove more useful to the bidders than murky information about prices across MTAs.

Collusion is a serious problem with the simultaneous auction. Under the simultaneous auction proposals, bidding on all of the licenses is open for an extended period of time, a month or more. This delay, coupled with the information revealed in the bidding, gives the parties ample opportunities to collude. For example, suppose two bidders found themselves among the high bidders in two markets, Boston and Philadelphia. They recognize the folly of continuing to raise each other in the two markets, so they agree that one firm gets Boston and the other gets Philadelphia. The simultaneous auction of all licenses provides a wealth of information about what agreements are likely to be profitable and gives the firms the time needed to make the collusive agreements.

Key to any collusive arrangement is the ability to enforce the agreement by punishing defectors. Simultaneous auctions give the parties full flexibility in punishing defectors. If the firm designated to win Boston continues bidding on Philadelphia, it can expect immediate retaliation from the designated Philadelphia winner. In contrast, if Boston and Philadelphia are auctioned in sequence, the Boston winner can safely bid against the designated Philadelphia winner, since Boston is already won. With sequential bidding, the Philadelphia bidder will not agree to stay out of Boston, since there is no way to assure that the Boston bidder will reciprocate.

Simultaneous auctions add complexity to the MTA auction design. With simultaneous auctions, the FCC faces more difficult implementation and a greater risk that the auction may fail. Many decisions must be made about stopping rules, activity rules, bid submission procedures, etc. Since the use of simultaneous auctions in an application of this scale is novel, prior experience offers the FCC little guidance with which to answer practical questions of implementation.

Sequential auctions can be conducted on a specific schedule. This is of great value to bidders interested in only a small subset of licenses. Bidders can schedule their planning and bidding days well in advance. At any one time, they can focus their attention on a small set of licenses. With simultaneous auctions, the bidders must participate throughout the entire process — a process of indeterminate length.

Although simultaneous auctions may have some theoretical advantages over sequential auctions, their practical problems make them an unwise choice.

3.3 Use a sequential English auction format.

The MTA licenses should be allocated by a sequence of 51 English auctions as follows. In each MTA except the Pioneer Preference markets, the A and B blocks are sold to the two highest bidders for the amounts of their bids. The higher bidder gets to choose between the A and B blocks. For example, if the two highest bidders for Dallas are MCI bidding $50 million and AT&T bidding $48 million, MCI pays $50 million for its choice of Dallas-A or Dallas-B and AT&T pays $48 million for the remaining Dallas block.

This procedure has many advantages. The English auction is an open ascending auction, so valuable information is revealed through the bidding process. This information reduces the winner's curse, enabling the bidders to bid more aggressively. Both efficiency and revenue maximization are enhanced by the open bidding process.

A second advantage of the English auction is that it is a familiar and straight-forward auction form. Implementing an English auction should be easy for the FCC. There should be no problems in finding a suitable auctioneer to conduct the auction on a timely schedule at little expense. The English auction is also easier on the bidders. Bidders can devote their attention to developing better valuation models, rather than finding ways to game complex auction rules. The English auction has an extensive history of success in a wide variety of applications. By using an English auction, the FCC can minimize the chance of a catastrophic breakdown in the auction process.

3.4 Sequence the auctions from largest to smallest, starting with the three Pioneer Preference markets: New York, Los Angeles, and Washington.

There is consensus among those proposing sequential auctions that the auctions should start with the largest MTAs and continue to the smallest. This promotes efficiency, since the largest MTAs are likely to be hubs in forming geographic aggregations. A bidder forming a Texas aggregation, would like to know the outcome in Dallas before bidding on Houston. By adopting a sequence that facilitates the formation of regional aggregations, aggregation risk is minimized, allowing the bidders to bid more aggressively. Auction revenues are thus enhanced, as well as efficiency.

The largest to smallest approach reveals valuable market information more quickly. Bidders hoping to develop nationwide services will learn quickly whether their plans can be profitably achieved. Based on the outcomes in the first several markets, these firms will be able to decide when it is time to switch to backup strategies.

Beginning with the Pioneer Preference markets is basically consistent with the largest to smallest approach. In addition, it means that the first three auctions will be even simpler, each involving only a single license.

3.5 Open and close the bidding on a license within a single session.

To minimize the opportunities for collusion, an auction for a particular market should open and close within the same bidding session. In contrast, Bell Atlantic's experts Nalebuff and Bulow recommend that the bidding for a particular MTA take place over two days and four bidding sessions, with the number of bidders reduced in each session (down to 10 in the first session, then 6, then 4, then 2). In addition to increasing complexity, this multi-session approach creates opportunities for collusion. As the identities of the high bidders become known, deals can be struck to avoid competition. This reduces revenues and corrupts the bidding process.

Nalebuff and Bulow argue that the multi-session approach gives the bidders an opportunity to consult with top management before bidding continues. With the single-session approach that I propose, bidding on key MTA licenses would likely be done by top management (or in constant communication with top management). Therefore, it is not necessary to stop the bidding to allow communication with top management. Breaking the bidding into multiple sessions simply facilitates communication among competitors.

It is also argued that multi-session bidding is needed to give the bidders time to react to new information. However, the MTA bidders are sophisticated large firms. A well prepared bidder will be able to react quickly to new information revealed by the bidding. Extended delays are not necessary.

3.6 Reveal bidder identities.

The benefit from revealing bidder identities is clear. Identities provide useful information for interpreting the bidding behavior of competitors. In particular, identities can help firms unravel whether aggressive bidding is indicative of a high private value or a high common value. For example, in bidding for Los Angeles, MCI might make different inferences if bidding against PacBell as opposed to Sprint. If the bidder is PacBell, MCI might infer that the aggressive bidding is due to synergies PacBell sees with its local exchange market.

Hiding identities is more difficult to implement, since mechanisms to preserve secrecy must be devised by the FCC. Some bidders may want there identities known. In this case, it would be difficult for the FCC to prevent the communication of identities. Even if bidders are visually separated, they could communicate their identities through their bids.

The problem with revealing identities is that doing so fosters collusion. This would be a serious problem, as discussed above, if bidding on a license occurred over several days. However, as long as the outcome is determined within a single bidding session, the opportunities for making collusive agreements are reduced. Therefore, I support revealing bidder identities as long as bidding on a license concludes within a single session.

3.7 Conclude the MTA bidding within two weeks.

An important advantage of this simple design is that it is possible to conclude the MTA bidding in a short period of time and still allow the bidders opportunity to react to new information. A sample two-week bidding schedule is shown in Table 1. This schedule involves only eight days of bidding, so that Wednesdays and the weekends can be used as extended breaks.

MTA bidders are sophisticated large firms. By the time of the auction, they will have invested significant resources in acquiring valuation information and developing bidding strategies. The strategies will tell them how to react to bidding outcomes. If New York sells for $500 million, a firm expecting New York to sell for $300 million should not need to go back to the drawing board. Surely, the firm considered the possibility of a $500 million sale and it knows how to respond in subsequent markets.

Experts arguing for a slow auction process have made the analogy made between corporate takeovers and the spectrum auction. This analogy is far from perfect. Takeovers typically involve only a few "bidders" in an "auction" that is often ill-defined, and may be better described as a negotiation. Time is needed to attract additional bidders and permit new bidders to gather and analyze investment information. In contrast, the spectrum auction is a highly organized auction with many well prepared bidders bidding for a large number of licenses. There is no need for a lengthy bidding process with knowledgeable and well prepared bidders. Long delays and a lengthy bidding process only give firms more opportunities to make collusive deals.

4 By emphasizing simplicity in the MTA auction design, the FCC avoids the risks inherent in more complex proposals.

There are substantial risks in adopting a complex auction design. Complexity increases the chance of inefficient allocations, of reduced auction revenues, and of delayed deployment of the PCS spectrum. Complex designs should be considered only if there is overwhelming evidence that the added complexity improves bidding outcomes. None of the complex designs, such as the simultaneous auction of both MTA and BTA licenses, comes with such evidence. Good theoretical arguments are made in favor of some of the complex designs, but equally good arguments for the simple designs can be made. In the end, the question of "best design" is an empirical question — a question that cannot be answered today for lack of data.

Since the FCC has only one chance to allocate the PCS spectrum, it must be concerned with the risks associated with the various designs. The sequential English auction proposed above is a clear winner once risks are considered. The design quickly allocates the most

Table 1. A Sample Two-Week MTA Auction Schedule

Day	MTA	% of Mhz-Pops Allocated
1. Monday	New York (B only) Los Angeles (B only) Washington (B only) San Francisco	17
2. Tuesday	Chicago Detroit Charlotte Dallas	18
3. Thursday	Boston Philadelphia Atlanta Minneapolis Tampa	16
4. Friday	Miami Houston New Orleans Cleveland Cincinnati St. Louis	13
5. Monday	Milwaukee Pittsburgh Denver Seattle Richmond Phoenix Louisville Memphis	14
6. Tuesday	Birmingham Portland San Antonio Indianapolis Des Moines Kansas City Buffalo Salt Lake City	10
7. Thursday	Jacksonville El Paso Columbus Little Rock Oklahoma City Spokane Nashville Knoxville	7
8. Friday	Omaha Honolulu Wichita Tulsa Alaska Puerto Rico Guam American Samoa	4

valuable parts of the PCS spectrum, using a method that has been thoroughly tested in countless applications. The proposed design assures that a majority of the value of the PCS spectrum will be allocated in a way that is highly efficient and raises substantial revenues for the government. The same cannot be said for the more complex designs. Their theoretical virtues come with a significant risk of inefficient delay or breakdown. Prudence demands adopting a simple design for the MTA auction.

Appendix: The BTA Auction

By separating the MTA and BTA auctions, the FCC has more flexibility in designing the BTA auction. Unanticipated problems with the BTA auction will not disrupt the MTA allocation. The FCC may even decide to experiment with alternative designs at the BTA level. However, I would recommend a simple and timely BTA auction.

In what follows, I sketch one possible design. This design is similar to that recommended by TDS's expert Weber and Bell Atlantic's experts Nalebuff and Bulow.

- Group the BTA licenses by MTAs. In each bidding session, all BTAs within a given MTA will be allocated. This is a natural grouping given the importance of MTAs in defining geographic markets for PCS. It also fosters an MTA aggregation of BTAs.
- Follow a schedule and sequence similar to the MTA schedule, but perhaps one-half as fast. Given the large number of licenses, a 16 day schedule seems about right. This pace is fast, but manageable, given all the information revealed during the MTA auction. Within an MTA, the BTAs should be sequenced from largest to smallest to facilitate aggregations around key BTAs.
- Auction the C and D blocks before the E-G blocks. This allows designated entities to know the outcome on the set-aside blocks before deciding to participate in the E-G blocks.
- Auction the E, F, and G blocks in a single English auction with identities revealed. The three licenses are sold to the top three bidders at the prices bid. The highest bidder has first choice among E, F, and G; the second-highest bidder has second choice; and the third-highest bidder gets the remaining license. A bid can be for a quantity from one to three. Hence, if the bidding ends and AT&T has the high bid of $9 million for one license and MCI has the second-highest bid of $8 million each for two licenses, then AT&T gets its choice of E or G and pays $9 million and MCI gets the remaining two licenses for $8 million each. (In the case of a winning double bid, it makes sense for the double bid to be for adjacent licenses; hence, AT&T's choice is limited to E or G.) Winning bids are chosen such that revenue is maximized. Thus, if the third-highest bid was $6 million for one license and a fourth bidder bids $10 million for one license, then the tentative winners are the fourth bidder at $10 million and MCI for two at $8 million each. The AT&T bid of $9 million is passed over because accepting it would drop the MCI double bid making the $6 million bid a winner for total revenues of $10 + 9 + 6 = $25 million, rather than $10 + 2(8) = $26 million. Consolidating E, F, and G in this manner is based on the assumption that the licenses are close substitutes and that the parties have identical preference orderings to the extent that values differ.

- Alternatively, if E, F, and G are not close substitutes, then a simultaneous ascending bid auction for all BTA licenses in an MTA could be conducted. This might be the case if it is important for an owner of adjacent BTAs to own the same band in each BTA.